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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B62M 9/14

A1

(11) International Publication Number: **WO 00/68068**

(43) International Publication Date: 16 November 2000 (16.11.00)

(21) International Application Number: PCT/NL00/00305

(22) International Filing Date: 10 May 2000 (10.05.00)

(30) Priority Data:
1012008 10 May 1999 (10.05.99) NL

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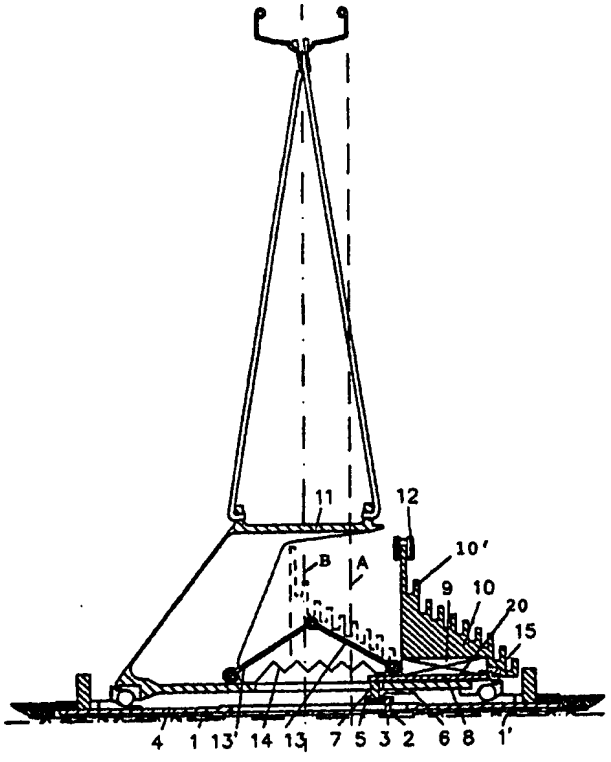
(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
In English translation (filed in Dutch).

(54) Title: GEAR DEVICE AMD METHOD FOR DRIVING A BICYCLE

(57) Abstract

A gear device for a bicycle comprising at least one driving sprocket, a sprocket cassette (10) including several driven sprockets (10') of varying diameter, a drive chain (12) which is in engagement with the driving sprocket and with one of the driven sprockets (10'), and a hub (11, 11') which forms part of a bicycle wheel, wherein the sprocket cassette (10) is axially in alignment with the hub (11, 11') and capable of exerting a dynamic torque on the hub (11, 11') by means of a torque transmitter (13, 13', 13'', 17), and wherein the sprocket cassette (10) is movable in axial direction so as to bring the drive chain (12) in engagement with the desired driven sprocket (10').



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GEAR DEVICE AND METHOD FOR DRIVING A BICYCLE

The invention relates to a gear device for a bicycle comprising at least one driving sprocket, a sprocket cassette including several driven sprockets of varying diameter, a drive chain which is in engagement with the driving sprocket and with one of the driven sprockets, and a hub which forms part of a bicycle wheel, wherein the sprocket cassette is axially in alignment with the hub and capable of exerting a dynamic torque on the hub by means of a torque transmitter.

The terms chain and sprockets as used herein are understood to include belts and pulleys.

A gear device of this type is the well-known derailleur system, wherein the drive chain is moved laterally for the purpose of selecting the correct sprocket. In most cases the chain will not run in alignment thereby. Because of its open construction, which can within reason not be combined with a closed chain guard, the derailleur system requires a great deal of maintenance and it is sensitive to shocks, and since the correct transmission ratio must be chosen by a suitable selection of front sprocket and rear sprocket, many people consider its operation user-unfriendly. The misalignment of the chain which occurs in most cases leads to additional wear and resistance. The alternative, a gear system which operates on the basis of gear transmissions within the hub (the hub gear) has a limited shifting range, a limited number of fixed transmission ratios and relatively high internal friction losses. Hub gear systems can be called relatively complex as regards their construction, which has a negative effect on the weight as well as on the

cost price.

The object of the invention is to provide a device of the above kind, wherein the aforesaid drawbacks are alleviated, comprising a large number of gears, a simple construction and for axial systems a small overall width, which is suitable for shifting gears under load and which can be efficiently sealed against dirt from outside.

According to the invention, the sprocket cassette is to that end movable in axial direction so as to bring the drive chain in engagement with the desired driven sprocket. In principle this enables a better alignment of the drive chain in every gear position in comparison with the derailleur system. Preferably, the drive chain is substantially fixed in axial direction near the driven sprocket, therefore.

Preferably, the bicycle wheel comprises a rim having a rim edge on either side, with one end of the sprocket cassette being axially movable to beyond the plane through the rim edge on the side where the sprocket cassette extends. More preferably, the end of the sprocket cassette is axially movable to beyond the centre plane of the bicycle wheel. This aspect enables a compact construction of the device, wherein the sprocket cassette can disappear into the hollow hub to a large extent.

Preferably, the sprocket cassette can be moved in axial direction by means of an activating medium, such as a cable and/or a chain which is connected to a control device. More preferably, said activating medium extends to within the hub, thus effecting a central operation of the gear device which is well-protected against outside influences.

Preferably, the gear device comprises a slide bearing and/or a roller bearing which enables the axial movement of the sprocket cassette.

Preferably, the gear device furthermore comprises a housing in which the sprocket cassette and the chain are at least partially accommodated, in such manner as to be protected in large measure against dirt from outside.

Preferably, the torque transmitter comprises at least one rod which is pivotally connected to the sprocket cassette or to the hub. Preferably, said rod is pivotally connected to a second rod, which is pivotally connected to the hub or the sprocket cassette to be connected. In another preferred embodiment, the rod is translatably connected to the hub or the sprocket cassette to be connected. Preferably, several torque transmitters are provided, which torque transmitters are sufficiently thick for transmitting the required forces. The rods are octagonal in section, for example, and preferably they are larger in diameter near the wheel axle than at a larger distance therefrom, which helps to achieve an effective transmission of forces.

In an alternative preferred embodiment, the torque transmitter comprises at least one roller, such as a ball or a bush, which can roll in axial recesses, for example in opposed grooves, in the sprocket cassette and the hub.

Preferably, the bearings which enable the axial movement and/or the torque transmitter are protected against dirt from outside by means of a seal, such as a bellows or membrane seal, an annular seal or a telescopic seal.

The invention furthermore relates to a bicycle, whether or not including an auxiliary motor, or a moped which is

fitted with a gear device.

The invention furthermore relates to a method for driving a bicycle, wherein at least one driving sprocket engages a sprocket cassette including several driven sprockets of varying diameter by means of a drive chain, wherein the sprocket cassette is axially in alignment with a hub which forms part of a bicycle wheel, and wherein said sprocket cassette exerts a dynamic torque on the hub by means of a torque transmitter, and wherein the sprocket cassette is moved in axial direction so as to bring the drive chain in engagement with the desired driven sprocket.

A large difference in the number of available transmission ratios can be realised by means of the invention, whilst sufficient gears are available all the same in the ideal range. For many uses one driving sprocket will suffice, as a result of which gear shifts can take place in a simpler manner by means of one control device, by means of which a higher or a lower gear can be selected. Shifting gears under a load is possible as well. The shifting mechanism is well-protected against damage and fouling, and in principle it is more reliable, therefore. If desired, it is possible to use a relatively compact, closed chain guard, with all the consequent advantages of a clean and low-maintenance system. Since the entire device is characterised by a certain simplicity, it becomes possible to manufacture good systems at an affordable price. By using inter alia a hub into which the gears can move as well as space-saving constructions for the seals of the axial bearing, the required space is reduced to a minimum. The combination of the selected technical solutions actually makes it possible to combine the advantages of the prior art derailleur and hub systems in the new system, whilst eliminating most

of the drawbacks. Thus the clean, low-maintenance construction as well as the reliability of the hub system is obtained. Also the advantages of the derailleur system can be realised, such as the large range of transmission ratios, a large number of transmissions and small friction losses, and thus a high transmission efficiency, and also, if desired, the advantages of the system which uses the principle of axial adjustment of sprockets, such as the chain alignment.

According to the invention, this is made possible by the special, hollow hub construction. In this construction, the driven sprockets can be moved in axial direction. Thus it becomes possible to arrange a large number of driven sprockets in side-by-side relationship (if there are no limitations as regards the overall width, there is actually no upper limit to the number of driven sprockets). Even in a standard frame with its limited width a great number of sprockets can be arranged side by side, if desired. A well-protected integrated adjusting device provides the axial movement of the driven sprockets. During a gear shift a guide arrangement fixes the chain in axial direction near the driven sprockets. When the driven sprocket cassette is axially adjusted during use, therefore, the chain will be forced to move onto another sprocket. Since the chain will run in the same line at all times, or, when two or three driving sprockets are used, practically in the same line, it becomes possible in combination with space-saving methods (not described herein) for tensioning and guiding the chain, to use a compact, closed chain guard. The construction of the system enables the use of simple seals, which have hardly any influence on the required space. The construction of the axial bearing and the manner in which the various forces are transmitted in the system enable easy gear shifts,

also under a load.

The invention will be explained in more detail hereafter by means of embodiments which are illustrated in the figures, wherein:

Figure 1 is a half cross-sectional view of a first embodiment of a gear device;

Figure 2 is a half cross-sectional view of a second embodiment of a gear device; and

Figure 3 is a half cross-sectional view of a third embodiment of a gear device.

Figure 1 is a cross-sectional view through the hub centre. Gear shifting takes place actively in two directions in the system as shown in the figure by means of activating medium 1, 1'. The gear-shifting command results in the activating medium 1, 1', represented as a chain and a pin in this embodiment, moving the cam holder 2. The activating cam 3, which extends through fixed axle 4, is connected to cam holder 2 and subsequently transmits the axial movement to activating bush 5, floating disc 6, control bush cam 7, control bush 8, freewheel device 9, driven sprockets 10. Floating disc 6, control bush cam 7, control bush 8, hub 11, freewheel device 9 and driven sprockets 10 rotate during gear shifts. Since chain 12 is fixed in axial direction, chain 12 will be forced to run over another sprocket 10' upon axial movement of activating medium 1, 1' and the resulting movement of sprockets 10. In this embodiment the sprocket cassette 10 consists of ten different sprockets 10', which are assembled to form one cassette. Ten gear positions are thus available. In this embodiment the transmission of the torque is effected by pairs of torque transmitters 13, 13'. A torque

transmitter 13 of one pair is pivotally connected to the second torque transmitter 13'. The second torque transmitter 13' is pivotally connected to hub 11. The pivot pins of the torque transmitters 13, 13' extend parallel to each other. This construction makes for better gear shifting under load and enables the use of simple seals in the form of a bellows 14 and a sealing ring 15. In the embodiment which is shown in the figure, the system is built up such that the imaginary planes of several more inward sprockets 10' can intersect the plane which abuts the rim edge (A). In the illustrated embodiment one of said sprockets 10' can even intersect the centre plane of the wheel. The use of slide bearing 20, which enables the axial movement, helps to make the system run smoothly.

Figure 2 shows an embodiment wherein, in contrast to Figure 1, the torque transmitter(s) 13'' are single torque transmitters; they engage directly in hub 11. The sprockets 10 are turned round, so that the largest sprocket is now positioned on the outside. Activation takes place by means of activating medium 1, 1' in the form of eccentrically guided cables. This enables a more aesthetic and more adequately protected cable mounting. Furthermore it is possible in this manner to use a drop-out hub. The sealing on the left-hand side of the sprocket cassette is realised by means of a membrane 16.

Figure 3 shows a variant of an embodiment, the difference with Figure 2 being that the bearing 21 which enables the axial movement includes rollers 17. Since the rollers 17 run in grooves, they can function both to effect the axial movement and to transmit the torque. The axle-shaped part of hub 11' is formed separately so as to be able to use a suitable material. A bellows seal 18 is present on the right-hand side of bearing 21, which is constructed with a view to saving space. One-

sided operation is started by means of activating medium 1, which co-acts with a spring 19, which takes care of the return movement.

Numerous variations are possible within the scope of the invention with regard to:

- The generation of a shifting command, for example by an automatic unit or a control unit activated by the rider.
- The medium which transmits the shifting command to the system. For example, a cable, a cable fitted at its end with an adjusting chain and a pin which co-acts either directly with the activating cams or via an activating pin. Furthermore the shifting command can be transmitted by means of a pneumatic, hydraulic or electric signal.
- The place where the medium is passed into the system, the left-hand side, the right-hand side or both sides and, depending on bearing position, through the centre of the fixed axle, eccentrically or through the centre when no fixed axle is present, which may be preferred when the system is adapted for use with a one-sided wheel suspension.
- Variants wherein the axial movement is effected by rotating a pin or constructions wherein the axial movement is effected by rotation of a roller.
- The manner in which the hub and the rim are interconnected. In this connection a traditional wheel with spokes may be considered, or an integrated construction with fixed spokes or a disc.
- The construction of the sprocket cassette such as: the combination of the various sprockets, the order in which they are mounted. Thus it may be advantageous for some uses to select a different order, for example an order wherein the smallest sprocket is positioned on the inside and the largest sprocket is positioned on the outside.
- The number of sprockets to be used. In principle there

are no limitations as regards the desired number of driven sprockets.

- The manner in which the chain tensioner and the chain guide are constructed. Since the chain guide does not need to make any axial movement as required with a derailleur system, technically simple and elegant solutions can be conceived. For example, the guiding device and the tensioning device can be separated, or the combined tensioning and guiding device can be disposed at a higher and more forward location, as a result of which it becomes possible to use a slim, closed chain guard which is not much larger than the generally known chain guards.

- A bush can be placed on the axle-shaped part of the hub and/or the control bush so as to obtain a suitable mating material for the bearing which enables the axial movement.

- Bearings, detail constructions and alternative shaping of parts.

Furthermore a gear device according to the invention can have the following characteristics, which can be used independently or in combination with each other: Discs or a bush can be placed on the activating cam(s) on the outside of the fixed axle, which discs or bush can mate with the floating discs. The activating medium can tension one or more springs in one direction, in such a manner that the energy required for the return movement is supplied by the spring(s). The activating medium can be directly activated in two directions. The mating parts which provide the axial adjustment can be screened from the environment by means of flexible seals, which are for example provided in the form of bellows or a membrane between the hub and the control bush, which may be constructed in such manner as to effect the transmission of the torque between the control bush and the hub as well.

The mating parts which provide the axial adjustment can be screened from the environment on one side by means of a (a) sealing ring(s), which is (are) provided between the control bush and the hub, whilst the slot or slots which are formed in the hub are so positioned that they will remain within the operating range of the sealing ring(s) at all times. The control bush and also the driven sprocket cassette, therefore, can be positioned exactly by a system comprising a centring ball which is urged into a recess by means of a spring, as well as similar constructions used for the same purpose, which employ a pin, for example, or a cam which falls / is urged into a recess. The activating pin can be positioned exactly by means of a system comprising a centring ball which is urged into a recess by means of a spring, as well as similar constructions used for the same purpose, which employ a pin, for example, or a cam which falls / is urged into a recess. Exact positioning can also take place in the adjuster, if desired.

The use of rollers, for example in the form of balls, which are rotatably mounted, albeit in a fixed position in the control bush and/or the hub, and which run in axial grooves, makes it possible to effect the axial movement between control bush and hub at low friction and to effect the transmission of the torque between the control bush and the hub. Several control bush cams may be used, which are provided with a bush which can rotate freely and which is capable of effecting the axial movement between the control bush cam and the hub at low friction and also of transmitting the torque between the control bush and the hub. The hub may includes keys or shims so as to make it possible to effect the axial movement between the control bush cam and the hub at low friction and also to transmit the torque between the control bush and the hub. Several control bush cams may be used, which are capable of effecting the axial

movement between the control bush cam and the hub at low friction and also of transmitting the torque between the control bush and the hub. The mating parts which provide the axial adjustment can be screened from the environment in that a number of telescopic, mating bushes are carried along when the control bush is being moved over the hub. It is possible to use rollers between the hub and the control bush, which rollers are capable of effecting the axial movement between the control bush cam and the hub at low friction. The control bush can be positioned on the outside of the axle-shaped part of the hub or on the inside of the hub. The freewheel device can be mounted in the floating part or between the hub and the rim. Finally, the hub can be directly mounted in bearings in the bicycle, that is, without the interposition of a fixed axle. This construction may be preferred, for example when using one-sided wheel suspension.

CLAIMS

1. A gear device for a bicycle comprising at least one driving sprocket, a sprocket cassette (10) including several driven sprockets (10') of varying diameter, a drive chain (12) which is in engagement with the driving sprocket and with one of the driven sprockets (10'), and a hub (11, 11') which forms part of a bicycle wheel, wherein the sprocket cassette (10) is axially in alignment with the hub (11, 11') and capable of exerting a dynamic torque on the hub (11, 11') by means of a torque transmitter (13, 13', 13'', 17), **characterised in that** the sprocket cassette (10) is movable in axial direction so as to bring the drive chain (12) in engagement with the desired driven sprocket (10').

2. A gear device according to claim 1, **characterised in that** the bicycle wheel comprises a rim having a rim edge on either side, with one end of the sprocket cassette (10) being axially movable to beyond the plane (10) through the rim edge on the side where the sprocket cassette (10) extends.

3. A gear device according to claim 1 or 2, **characterised in that** one end of the sprocket cassette (10) is axially movable to beyond the centre plane (B) of the bicycle wheel.

4. A gear device according to any one of the preceding claims 1 - 3, **characterised in that** the sprocket cassette (10) can be moved in axial direction by means of an activating medium (1, 1'), such as a cable and/or a chain which is connected to a control device.

5. A gear device according to claim 4, **characterised**

in that said activating medium (1, 1') extends to within the hub (11, 11').

6. A gear device according to any one of the preceding claims 1 - 5, **characterised in that** the drive chain (12) is substantially fixed in axial direction near the driven sprocket.

7. A gear device according to any one of the preceding claims 1 - 6, **characterised in that** the gear device furthermore comprises a housing in which the sprocket cassette (10) and the chain (12) are at least partially accommodated, in such manner as to be protected in large measure against dirt from outside.

8. A gear device according to any one of the preceding claims 1 - 7, **characterised in that** the torque transmitter comprises at least one rod (13, 13'') which is pivotally connected to the sprocket cassette (10) or to the hub (11).

9. A gear device according to claim 8, **characterised in that** said rod (13) is pivotally connected to a second rod (13'), which is pivotally connected to the hub (11, 11') or the sprocket cassette (10) to be connected.

10. A gear device according to claim 8, **characterised in that** said rod (13'') is translatably connected to the hub (11) or the sprocket cassette (10) to be connected.

11. A gear device according to any one of the preceding claims 1 - 7, **characterised in that** the torque transmitter comprises at least one roller (17), such as a ball or a bush, which can roll in axial

recesses, for example in opposed grooves, in the sprocket cassette (10) and the hub (11').

12. A gear device according to any one of the preceding claims 1 - 11, **characterised in that** the device furthermore comprises a slide bearing (20) and/or a roller bearing (21) which enables said axial movement.

13. A gear device according to any one of the preceding claims 1 - 12, **characterised in that** the bearings (20, 21) which enable the axial movement and/or the torque transmitter (13, 13', 13'', 17) are protected against dirt from outside by means of a seal (15, 16,18), such as a bellows or membrane seal, an annular seal or a telescopic seal.

14. A bicycle, whether or not including an auxiliary motor, or moped comprising a gear device according to any one of the preceding claims.

15. A method for driving a bicycle, wherein at least one driving sprocket engages a sprocket cassette (10) including several driven sprockets (10') of varying diameter by means of a drive chain (12), wherein the sprocket cassette (10) is axially in alignment with a hub (11, 11') which forms part of a bicycle wheel, and wherein said sprocket cassette (10) exerts a dynamic torque on the hub (11, 11') by means of a torque transmitter (13, 13', 13'', 17), **characterised in that** the sprocket cassette (10) is moved in axial direction so as to bring the drive chain (12) in engagement with the desired driven sprocket (10').

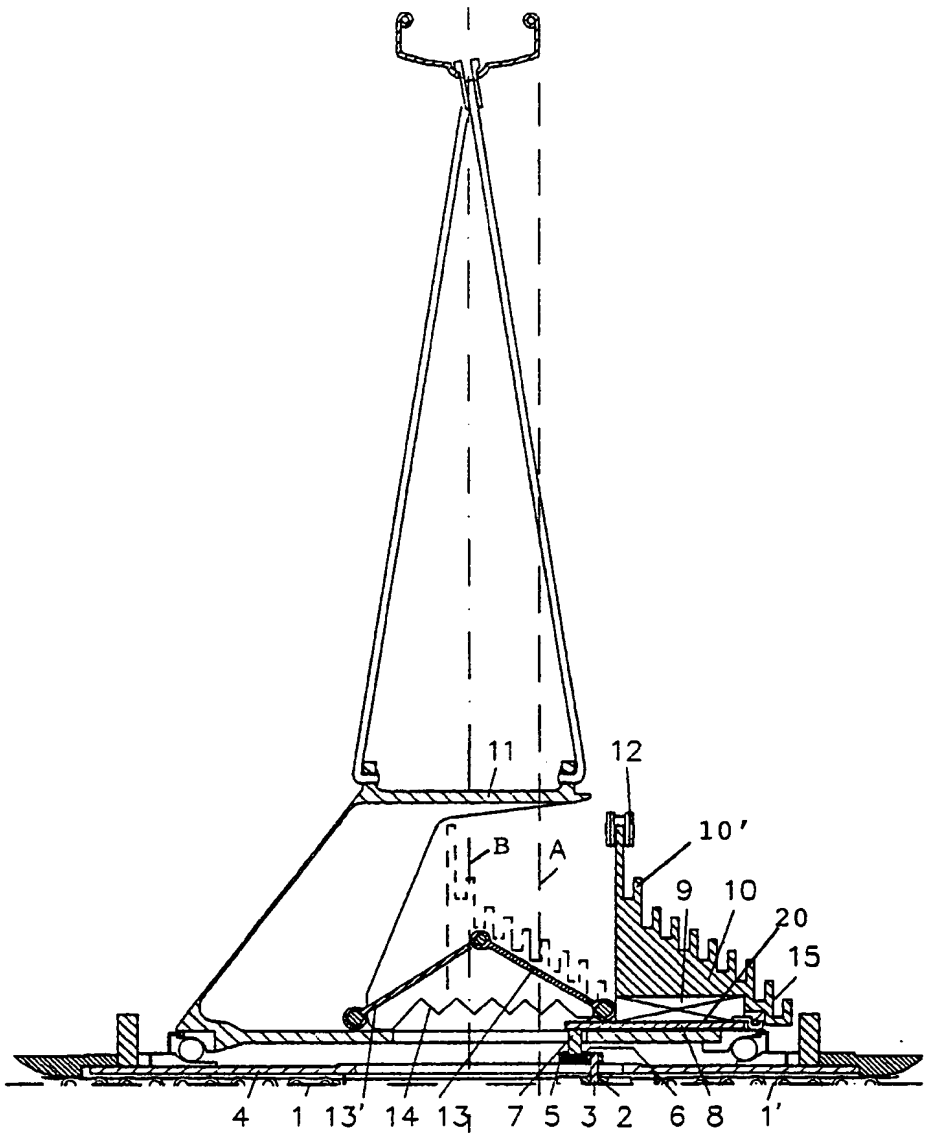
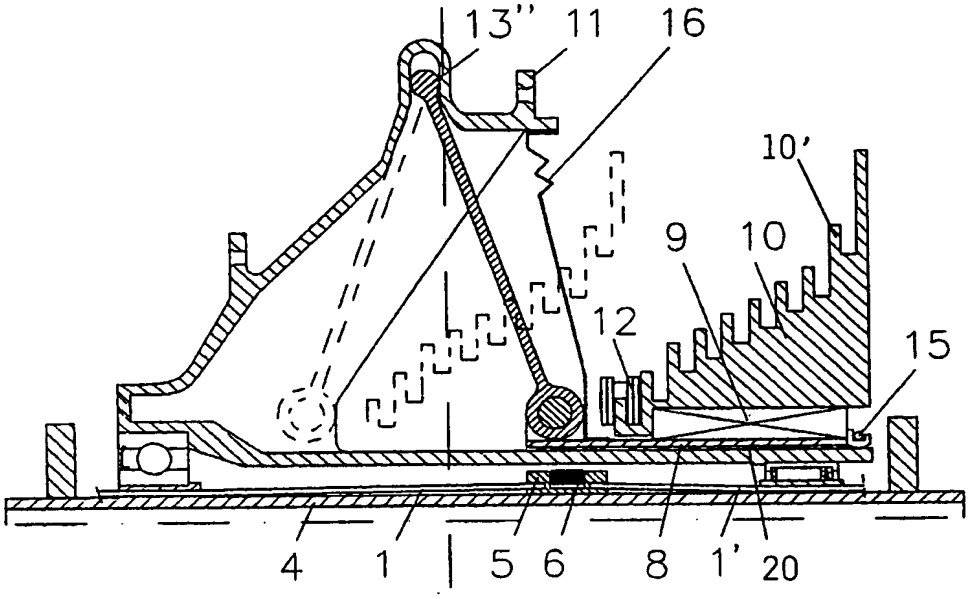


FIG. 1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11
16
10'
9
10
12
15
4
1
5
6
8
1'
20

FIG. 2

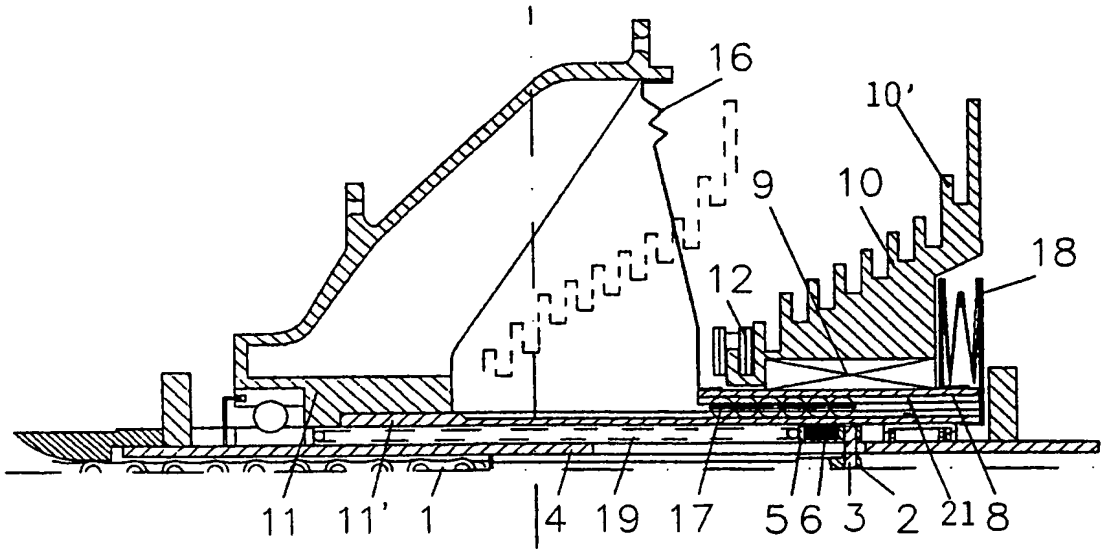
16
10'
9
10
18
12
11
11'
1
4
19
17
5
6
3
2
21
8

FIG. 3

INTERNATIONAL SEARCH REPORT

Inte ional Application No
PCT/NL 00/00305

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B62M9/14

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B62M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	FR 2 610 060 A (SUTEAU) 29 July 1988 (1988-07-29) abstract; figure 1 -----	1,15 2-4,6-8, 12-14

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Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2000	04/08/2000

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2610060 A	29-07-1988	NONE	